For a box model

$EV_{sum}$ = #draws · avg box

$SE_{sum}$ = $\sqrt{\#draws}$ · SD box

Binary box model
(only 0 and 1's)
(binomial)

$EV_{\%}$ = % or 1's in box

= avg · 100%

For a box with only 0 and 1's

n 0 R 1

$$avg = \frac{n \cdot 0 + 1 \cdot R}{n+R}$$

$$= \frac{R}{n+R}$$

when $n \geq 1$,

$$\frac{R}{n+R} < 1$$

$$SE_{\%} = \frac{SE_{sum}}{\#draws} \cdot 100\%$$

$$= \frac{\sqrt{\#draws} \cdot sd}{\#draws} \cdot 100\%$$

$$= \frac{SD}{\sqrt{\#\text{draws}}} \cdot 100\%$$

as # draws ↑

$SE_{\%} \to 0.$

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$EV_{avg}$ = avg of the box.

$$SE_{avg} = \frac{SE_{sum}}{\#\text{draws}}$$

$$= \frac{SD}{\sqrt{\#\text{draws}}}$$

as # draws increase

"converge" to EVavg

**Correction Factor**

So when we do a simple random sample we sample without replacement

$$SE_{w/o\,rep} = SE_{w/rep} \cdot CF$$

$$CF = \sqrt{\frac{pop\,size - sample\,size}{pop\,size - 1}}$$

$CF \approx 1$ if pop size $\gg$

Sample size

We use CF when
Sample size $\geq 10\%$
of pop size